

# PSL



Power Standards Lab

# PSL



## PQube® AC Power Monitor

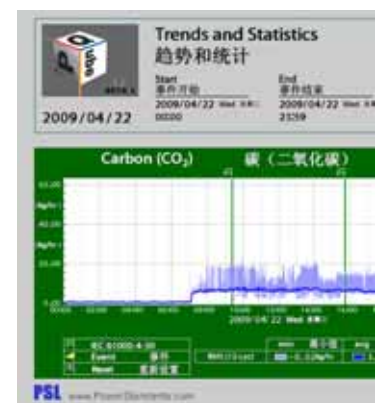
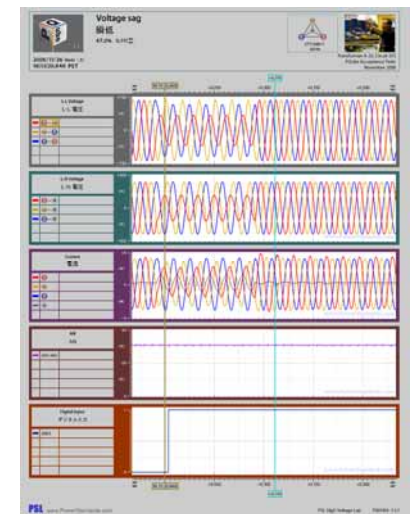
Embedded power quality and energy/carbon monitoring

### Highlights

- An entirely new idea: combine a hyper-accurate energy monitor with a world-class power quality monitor. Then squeeze it into a compact, low-cost package that doesn't require any software at all.
- Captures disruptive voltage disturbances every time they occur. Time-stamped pictures of the waveforms, and Excel®-compatible CSV spreadsheet files.
- Energy and peak metering, including kilowatt-hours, kVA, kVA-hours, true Power Factor, peak amps, peak kVA, peak watts, unbalance, and a Carbon footprint meter that uses a patent-pending algorithm.
- Tiny. Perfect for embedding in sensitive equipment – quickly reduces service costs and provides critical data for improving energy efficiency.
- As easy to use as a digital camera – everything you need is stored on a standard plug-in SD card.
- Made in USA. No software required. Very low cost.

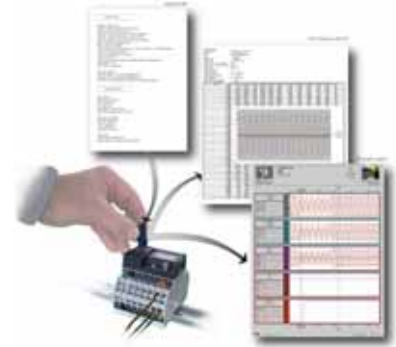
### Features

- **General:**
  - Three-phase/single-phase voltage monitoring – standard worldwide voltage configurations up to 690V L-L (400V L-N), 50/60/400Hz nominal.
  - Auto power configuration (patent pending) – detects single-phase, phase-to-phase, delta, wye, corner ground, and many others. Also auto-detects nominal voltage and nominal frequency.
  - One digital input, two additional  $\pm 60V$  analog input channels, one relay contact output, and two temperature-humidity channels.
  - 256 samples-per-cycle recording.
  - 2 gigabyte SD-card standard (can use up to 8GB cards). Typically records about 1 GB per year.
  - Full color organic LED display: 25+ languages, date/time setup, most recent events, meters, etc
  - DIN-rail or panel mount
  - Power from 24-48VDC/24 VAC, or optional 100~240 VAC power supply. Built-in Li-Ion UPS
  - Free individual NIST calibration certificate for every PQube. Download from [www.PowerStandards.com](http://www.PowerStandards.com)
- **Power Quality monitoring:**
  - Voltage dips, swells, and interruptions – waveforms and RMS graphs
  - Over-frequency and under-frequency events
  - 1-microsecond high-frequency impulse detection
  - Time-triggered snapshots
  - THD, TDD, Voltage unbalance, and current unbalance
  - RMS Flicker –  $P_{inst}$ ,  $P_{ST}$ ,  $P_{LT}$
  - Detailed event recording, plus daily, weekly, monthly trends. Cumulative probability, histograms, and more
- **Energy monitoring:** Just snap on a plug-in current module
  - Watts, VA, VAR's, true Power Factor, Watt-hours, VA-hours
  - Carbon footprint meter. You can specify carbon values for various types of electric power, and the ratio of each type supplied by your electric company. Your PQube then measures the carbon footprint directly in kilograms! It even distinguishes between "generated" and "avoided" CO<sub>2</sub>
  - Peaks: single-cycle peak, 1-minute, and 15-minute averages
  - CT ratios support up to 50,000 amps. PT ratios support up to 6,900,000 volts.
  - Daily, weekly, monthly trends, Load duration curves and more.



- **No software required:**

- Spreadsheets: CSV Excel-compatible files; events, trends, statistics
- Pictures: Event and trend/statistics – dual-language graphs output directly from your PQube in universal GIF format
- PQDIF: the IEEE's standard for power quality data files
- Text, XML, and HTML summaries: perfect for interfacing with other programs



- **Easy data retrieval:**

- Easy access to all PQube graphs, spreadsheets, and PQDIF files - simply pop out SD card from front slot. No communications required. No restrictions from your IT department.
- Open file formats:
  - Graphs in GIF format with dual language labels
  - Spreadsheets in CSV format
  - PQDIF format for events, trends, and statistics
  - Summaries in text, html (web), and XML (computer readable) formats
  - HTML (web browser) indexes make it easy to find files
- With optional Ethernet plug-in module, you add:
  - Email – trends and statistics and events, straight from your PQube to your PC. Email is a great choice for locations where firewalls are an issue. Your PQube supports encrypted e-mail passwords, too, for greater compatibility with servers that require MD5.
  - Web server built-in – easy viewing and downloading from anywhere in the world.
  - FTP server built-in – easy file transfer from anywhere in the world.
  - Modbus-TCP – meters can be read by thousands of programs



Event				
Event Type	Voltage Dip			
Event Magnitude	88.8%			
Event Duration in Seconds	8.107			
Trigger Date	2009/04/14			
Trigger Day of Week	Thursday			
Trigger Time	T 14:27:16.738 PST			
Trigger Channel	L1-L2			
Trigger Threshold	90.0% of nominal			
Min Max Readings				
Channel	Min	Max	Min	Max
L1-L2	212.7V	232.7V	212.7V	227.7V
L2-L3	221.0V	231.7V	221.0V	226.7V
L3-L1	229.2V	237.0V	229.2V	229.0V
L1 Amp	55.3A	231.6A	91.5A	231.6A
L2 Amp	78.2A	154.6A	136.9A	154.6A
L3 Amp	72.1A	260.0A	232.4A	260.0A
Frequency	60.0048Hz	60.0168Hz	60.0096Hz	60.0128Hz
Power	13.019W	68.295W	38.076W	68.295W

- **Easy installation**

- Snap-together modules for Ethernet, current, optional power supply, and more
- Direct connection to any world-wide voltage: 100V, 120V, 200V, 208V, 230V, 240V, 277V, 400V, 480V, 600V. 690V.
- Direct connection to any world-wide frequency: 50 Hz, 60 Hz, plus DC
- DIN-rail mount or panel mount. Can snap into standard DIN circuit-breaker box with standard 45mm cutout.
- Built-in UPS with automatically charged Li-Ion battery. Battery can be easily replaced without interrupting PQube monitoring



- **Complies with world-wide standards:**

- Safety: UL, TUV, ISA-82.02.01 (IEC 61010-1 MOD), CAN/CSA-C22.2 NO.61010-1, Japan S-mark, GS
- Immunity: IEC 61000-4-5 (6kV peak 100kHz surge), IEC 61000-4-4 (4kV peak EFT bursts), IEC 61000-4-2 Level 1 and MIL-STD-883 (electrostatic discharges), IEC 61000-4-3 (radio frequency fields), IEC 61000-4-8 (magnetic fields)
- Emissions: EN 55022 and CISPR 22, radiated and conducted RF emissions.



# PSL

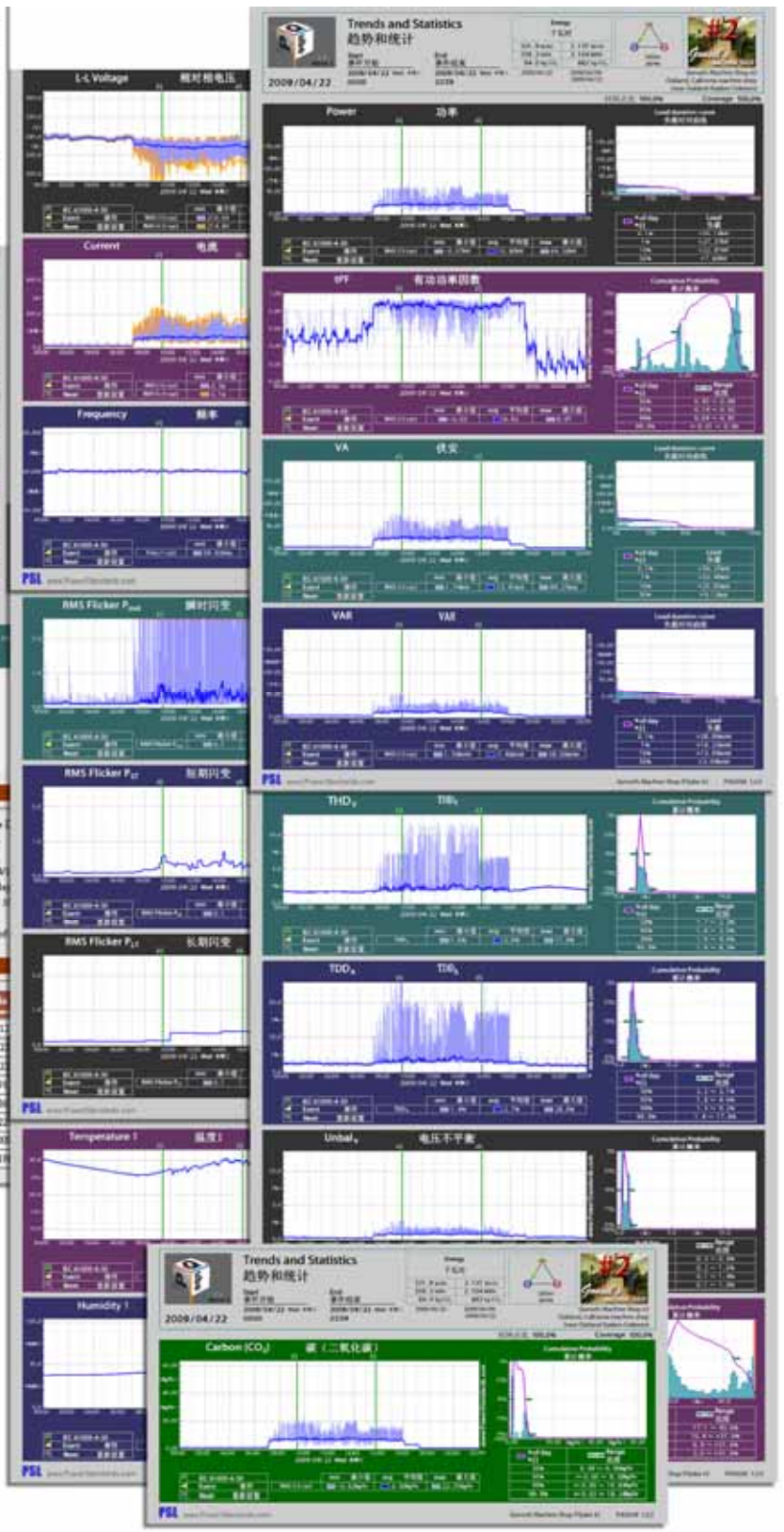
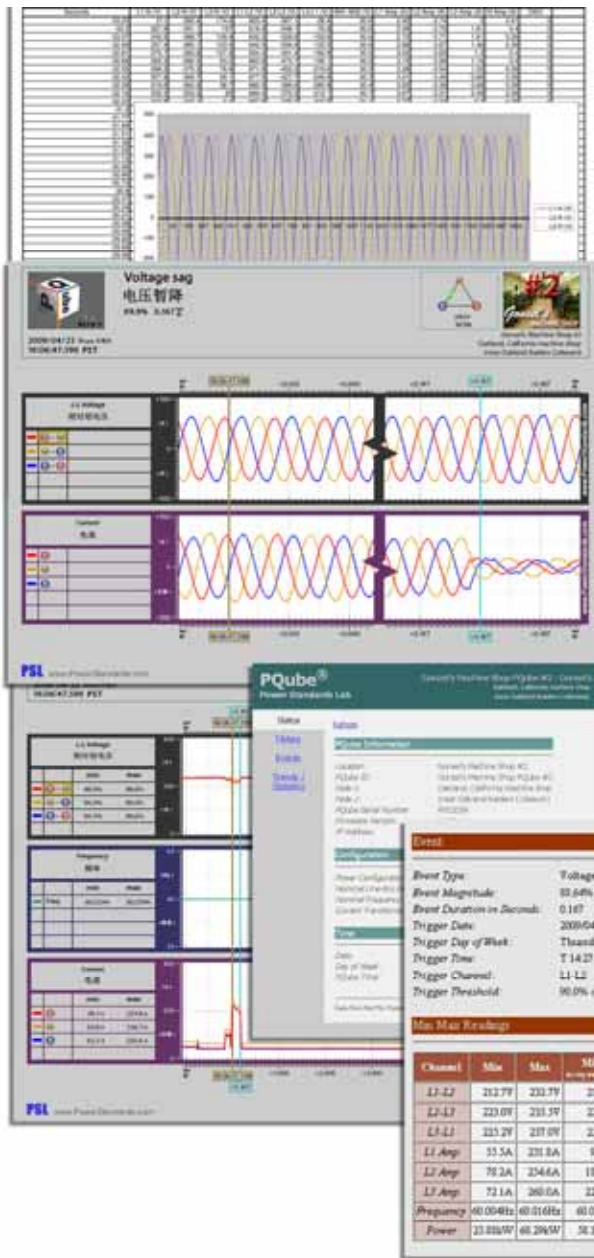
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## Applications

- **Industrial equipment**
  - Size and price are perfect for embedding in automated machinery
  - Quickly pay for PQube with avoided service calls
  - Track energy trends over time – detect developing leaks, failing motors, and more
- **Medical**
  - Perfect for embedding in MRI and CAT scanners.
  - Detect power quality events that cause intermittent errors, imaging malfunctions.
  - Provide energy monitoring: the first step in improving energy efficiency in medical facilities
- **Security scanning at airports**
  - World-wide necessity – must function perfectly with bad power
  - Scanning errors can be catastrophic - embedded power quality monitoring is critical.
- **Power companies**
  - Monitor key accounts at the meter, and at the critical loads: was it your problem, or a facility problem?
  - Lowest-cost system-wide monitoring – including PQDIF output files
- **Facility management companies**
  - Add value with power quality and energy monitoring
  - PQube is the only monitoring system that doesn't require network infrastructure – just install and get useful data right away
- **Military bases, government campuses, large facilities**
  - Allocate energy costs, and detect energy leaks
  - Full carbon monitoring for green initiatives
  - Start with no network; add e-mail later; then add full network support when needed
- **Data centers**
  - AC and DC monitoring, plus temperature and humidity
  - Monitor input and output of power conditioning – demonstrate your improvements
- **Telecom**
  - 3-phase and 1-phase AC monitoring, with simultaneous capture of disturbances on -48Vdc
  - Trigger on AC disturbances, -48Vdc disturbances, or both
  - Full daily, weekly, and monthly trends and statistics for proof of service
- **Researchers**
  - All data stored in open-format files (Excel®-compatible CSV files) – easy to write your own programs for analysis
  - Voltage, current, and DC oscilloscope waveforms, with sophisticated triggering
  - Daily, weekly, and monthly trends and statistics: voltage, current, frequency, power, temperature, humidity, and more
- **Green initiatives**
  - Direct reading of carbon emissions, using patent-pending algorithms
  - Ultimate precision: 0.05% accuracy for sensitive energy savings measurements
- **Distributed generation - wind and solar**
  - Ultra-precise 3-phase AC measurements, including net power flow
  - Ultra-precise frequency recording and disturbances for stability analysis
  - Detect LVRT (voltage dip) faults – speeds up acceptance tests and payment
  - Available 1500 Vdc and 600-amp DC sensors, simultaneous with built-in AC sensors, for inverter efficiency measurements, recording DC bus disturbances
- **Energy audits and Power Quality consulting**
  - Direct graph outputs (GIF format) that copy/paste into your reports – no software required
  - Accumulated energy, peak energy, and daily/weekly/monthly trends and statistics for full understanding
  - The most accurate, most flexible, easiest-to-use power recorder ever made for energy and power quality



# Sample Files



From this PQube ...



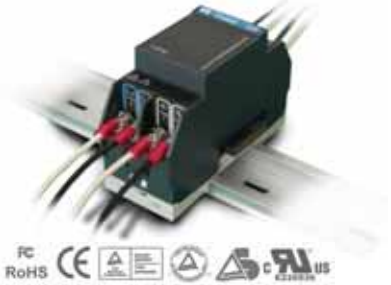
...you get all these, and more.  
With no software.

## Optional Plug-in Modules



### Current Sensing modules

- Four channels of current monitoring.
- Simple to set CT ratios in your PQube (up to 50 kiloAmps), with crest factor of 400%.
- Current waveforms, inrush current, and power flow (kW, kWh, kVA, kVAh, kVAR, kVARh, tPF)
- Peak meters – peak amps, peak kVA, and peak watts. Single-cycle, 1-second, and 1-minute peaks. Useful for sizing circuit breakers, UPS, and transformers.
- Carbon footprint meter – input your local electric power source information, and your PQube automatically measures your CO<sub>2</sub> footprint directly in kilograms

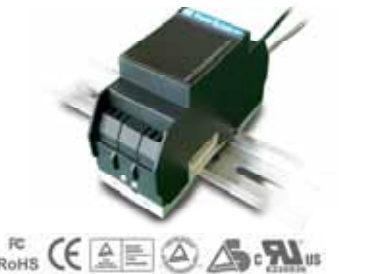


### CT4 Current Sense module

- Just pass wires through openings in module (0.34in (8.6mm) maximum diameter)
  - Part Number CT4-20A-00 for 20-amp nominal rating
  - Part Number CT4-100A-00 for 100-amp nominal rating.

### XCT4 Current Transformer Interface module

- Connects directly to current transformer secondary wires – 1 or 5 amp, and 1, 5, or 10 volt.
  - Part Number XCT4-01A-00 for 1-amp nominal rating
  - Part Number XCT4-05A-00 for 5-amp nominal rating
  - Part Number XCT4-0.333V-00 for 0.333-volt nominal rating
  - Part Number XCT4-01V-00 for 1-volt nominal rating
  - Part Number XCT4-05V-00 for 5-volt nominal rating
  - Part Number XCT4-10V-00 for 10-volt nominal rating



### PS1 - Power Supply module

- PS1 Power Supply Module lets your PQube take power from 100V~240V, 50/60 Hz. (Your PQube takes power from 24VAC, 24Vdc - 48Vdc without any optional modules.)
- Snap multiple PS1 modules together for redundant power from different feeders
  - Part Number PS1-100~240-00



### ETH1 - Ethernet module

- Automatically sends you an e-mail whenever a disturbance occurs, complete with picture and Excel® compatible attachments
- Built in web server – see status of your PQube and look at event and trend recordings
- Update your firmware and reset your PQube via email
- Use SNTP for synchronizing (2 second absolute) to UTC time standard
- DHCP/Fixed IP, POP, SMTP, FTP, Modbus-over-TCP
  - Part Number ETH1-10T-00

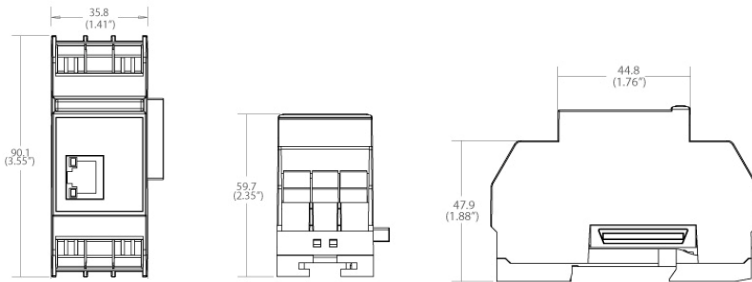


### TH1 - Temperature-Humidity probe

- Monitors ambient temperature and humidity
- Every PQube accepts two electrically-isolated probes
- Use one probe for local ambient temperature-humidity, and put the other on an optional extension cable for monitoring remote conditions
- Temperature accuracy- Typical: ± 0.5°C
- Humidity accuracy: Typical: ± 4.5%RH (20~80% R.H)
  - Part Number TH1-80C-00

## Physical dimensions

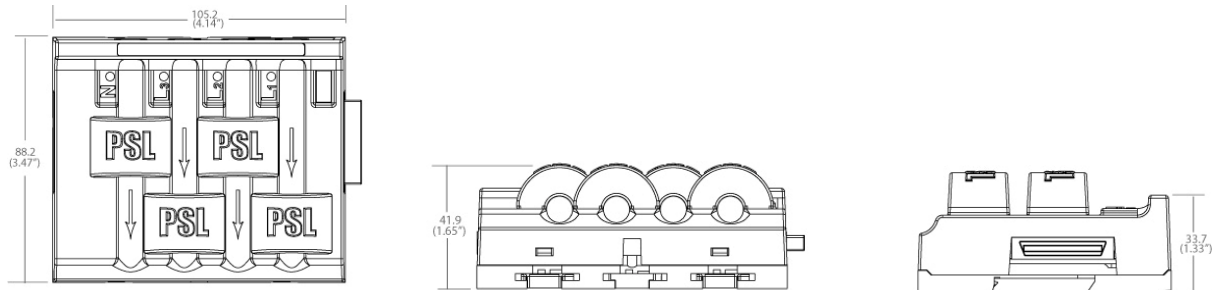
- **Plug-in modules: PS1, ETH1, XCT4**



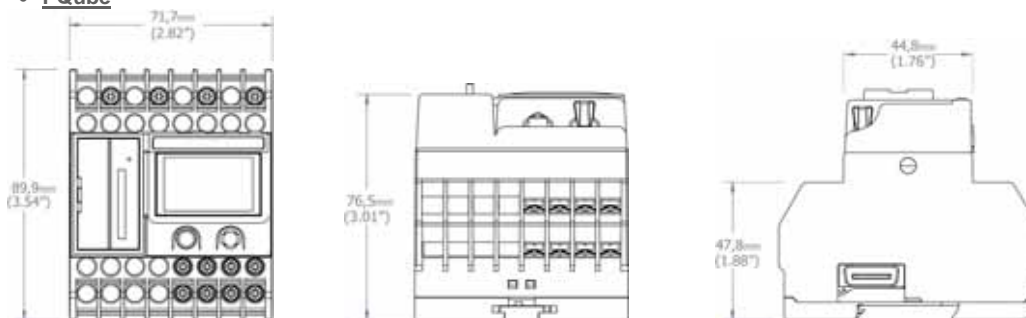
- **TH1 Temperature-Humidity Probe**



- **Plug-in module: CT4**



- **PQube**



Actual Size



PSL



Abbreviated PQube Specifications Version 1.2.2(e) -- Full specification available at [www.PowerStandards.com](http://www.PowerStandards.com)  
Reference conditions for factory tests: 19~25°C, 15%~50% RH, steady-state 10/12 cycle signals. ±1/2 display count on all accuracies.

Inputs	
<b>Mains Voltage Measuring Channels</b>	
Connection	L1, L2, L3, N PQube screw terminals [9], [11], [13], [15]
Frequency Range	40Hz~70Hz and 320Hz ~ 560Hz. Nominal 50Hz, 60Hz, or 400Hz auto-selected. 320Hz ~ 560Hz manually selected
Mains Configuration	Single-phase, delta, wye or star. User selected or auto-selected
Nominal Input Voltage	100VAC~690VAC L-L (69VAC~400VAC L-N) User selected or auto-selected
Measurement Channels	Line-to-Neutral, Line-to-Line, Neutral-to-Earth
Sampling Rate	256 samples per cycle, phase-locked to input frequency
Measurement Range	0 VAC ~ 900 VAC L-L (520 VAC L-N)
Accuracy	±0.05% rdg ±0.05% FS typical (10% ~ 150% of nominal). Every PQube factory tested at better than ±0.04%rdg ±0.04%FS. Note: FS is based on measurement range.
HF Impulse Detection	L1-E, L2-E, L3-E. ±450V <sub>pk</sub> nominal threshold detected through 2-pole high-pass 4.8 kHz nominal filter. Every PQube factory tested with 1-µsecond 10%-to-90% impulses; trigger required at ±650V <sub>pk</sub> , must not trigger ±250V <sub>pk</sub> .
Unbalance - voltage	Measurement method ANSI C84.1. Range: 0.0% - 100.0% Accuracy equivalent to rms voltage specification applied to measurement method.
THD - voltage	Measurement method: Discrete Fourier Transform of phase-locked 256-samples-per cycle. Range: 0.0% - 100.0% Accuracy: ±0.2% at test waveform having typical harmonic content (5% 5 <sup>th</sup> , 2.5 7 <sup>th</sup> , 1.5 9 <sup>th</sup> , and 1% 11 <sup>th</sup> ). Samples measured through 6-pole low-pass analog anti-alias filter, 3 dB frequency 4.7 kHz.
RMS Flicker	P <sub>inst</sub> - average absolute difference between U <sub>RMS1</sub> and 1-second RMS, in percent of nominal, multiplied by scaling factor for improved compatibility with Incandescent Flicker in IEC 61000-4-15. P <sub>ST</sub> - mean value of P <sub>inst</sub> over previous 10 minutes, synchronized to real-time clock. P <sub>LT</sub> - mean value of P <sub>inst</sub> over previous 2 hours, synchronized to real-time clock. Range 0.0 ~ 20.0. Accuracy ±0.1.
Isolation	PQube provides more than 7500 VDC isolation to Earth. UL/IEC 61010 reinforced insulation.
PT Input Ratio Range	1:1 to 10000:1
Installation Category	CAT IV UL/IEC 61010 for voltages up to 300VAC L-N (equivalent to 480VAC L-L), CAT III for higher voltages. Pollution Degree 2
<b>Analog Input Channels</b>	
Connection	AN1, AN2 PQube screw terminals [22], [30]
Nominal Input	0~30VAC or ±60VDC (to Earth) max
Full Scale	70VAC, ±100VDC
Measurement Channels	AN1-Earth, AN2-Earth, AN1-AN2
User-specified Input Ratio	1:1 to 10000:1
Sampling Rate	12.8kHz or 15.4kHz (measured at same rate as mains voltage measuring channels)
Accuracy	±0.2% rdg ±0.2% FS typical (10% ~ 100% FS). Every PQube factory tested at better than ±0.1% rdg ±0.1% FS AC.
<b>Digital Input</b>	
Connection	DIG1 PQube screw terminal [24]
Rating	60VDC to Earth
Wetting	5.4VDC at 3µA
Threshold	1.5V±0.2V with respect to PQube's Earth terminal, with 0.3V hysteresis typical
Sampling Rate	12.8kHz or 15.4kHz (sampled at same rate as mains voltage measuring channels)
<b>Optional Current Measuring Modules</b>	
<b>CT4</b>	
Measurement Type	Pass-through (built-in current transformers)
Accuracy	±0.2% rdg ±0.2% FS typical (10% ~ 120% FS). Every PQube factory tested at better than ±0.15% rdg ±0.15% FS.
Burden	less than 0.1VA
Conductors	0.34 inches (8.6mm) max. diameter, 600V UL-recognized insulation required
<b>XCT4</b>	
Measurement Type	External current transformer
CT Input Ratio Range	1:1 to 10000:1
Accuracy	Excluding external CT's ±0.2% rdg ±0.2% FS typical (10% ~ 120% FS). Every PQube factory tested at better than ±0.15% rdg ±0.15% FS.
Burden	Less than 0.1VA
Wire Connection	Min. 20AWG (0.52 mm2), Max. 14AWG (2.1mm2). 600V UL- recognized insulation required
<b>Instrument Power</b>	
<b>Screw Terminals</b>	
(AC or DC) PQube POWER screw terminals [23], [31]	
AC Input	24VAC ± 20% 50/60 Hz
DC Input	24-48VDC ± 20% (polarity independent)
Power Required	5VA max
<b>Internal UPS</b>	
Type	Lithium Polymer Battery (replacement batteries available from PSL)
Capacity	600mAh (30 minutes typical with new, fully-charged battery)
Backup Period	User controlled. 1 to 10 minutes, 3 minute default.
<b>Optional PS1 Plug-in Module</b>	
AC Input	100~240VAC ± 10%. 50/60 Hz
Power Required	25VA max
Isolation	Module provides more than 3200VDC isolation to all other circuits
<b>Power measurements</b>	
<b>Definitions</b>	
Watts (power)	Sum of true instantaneous per-phase power
Volt-Amps (apparent power)	Sum of per-phase product of RMS voltage and RMS current, taken over the measurement interval
Power Factor (PF)	True power factor - ratio of Watts to Volt-Amps.
VAR's (volt-amps reactive)	Budeanu definition
Carbon	Based on patent-pending algorithm using watts and user-selected proportions of generator sources, and user-supplied carbon generation rates for each source.
Current Unbalance	Measurement method ANSI C84.1.
<b>Accuracy excluding external CT's</b>	
Watts (power)	±0.25% at unity power factor, nominal voltage, 20% ~ 100% FS current. Class 0.5 ANSI C12.20-1998. Better than ±0.25% rdg ±0.25% FS (10% ~ 120% FS), for phase angle (fundamental = ±30° (angle between fundamental voltage and fundamental current). Accuracy calculation: sum of voltage accuracy, plus current accuracy, plus phase angle correction which is guaranteed less than ±0.025% x (1 / cos(fundamental)).
Volt-Amps (apparent power)	Better than ±0.25% rdg ±0.25% FS typical (10% ~ 120% FS)
<b>Measurement interval</b>	
Measurement interval	Phase-locked, 10-cycles (50 Hz nominal) or 12-cycles (60 Hz nominal). Approximately 5 readings per second. Actual readings per second dependent on actual frequency.
<b>Operating Environment</b>	
Ambient Conditions	Operating -20°C ~ 50°C, 10%~90% RH
Transient Voltages	100kHz ring wave 6 kV pk, IEC 61180, IEC 61000-4-5. Applied to voltage measuring terminals with Performance Evaluation Class 1. (When applied to optional power supply mains terminal, supply's fuse may operate in PE Class 3 at test levels greater than 4 kV.)
EFT Burst Immunity	4 kV pk, IEC 61000-4-4, Performance Evaluation Class 1. Applied to power measuring terminals and optional PS1 power supply mains terminals
RF Field Immunity	3V / m, IEC 61000-4-3 Test Level 2
Magnetic Field Immunity	30A / m, IEC 61000-4-8 Test Level 4
Ingress Protection Rating	(IP Rating) IP20H, IEC 60529
<b>Agency Approvals and Listings</b>	
UL	UL-recognized, cULus - File Number E220936
RoHS	Certified - PSL Construction File PQube-001
CE	Certified - PSL Construction File PQube-001, TUV CB Test Certificate US-TUVR-4368-A2
EMC	Certified - 20080102-01-CE, 20080326-01-RI
TUV Bauart-mark	Certified - TUV Report 30880881.009

For application questions, check pricing and availability, please contact us. We stock and distribute the PQUBE products throughout North America.



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POWERful SOLUTIONS

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